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GB 2295993 A GB 1183920 A US 5194199 A
US 3842944 A

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(54) Abstract Title
Energy-absorbing element

(57) An energy-absorbing element, which is produced using metal foam, for use in vehicles, in particular in motor vehicles, has fastening elements 18 for attaching it to the vehicle structure. In order to improve the absorption performance, with the option of influencing this performance in a controlled manner using simple measures, the element is produced in the finished state as a shaped body 10, which is adapted to the energy-absorption performance which is desired in a specific application, directly in the foaming process with a closed outer skin 22.

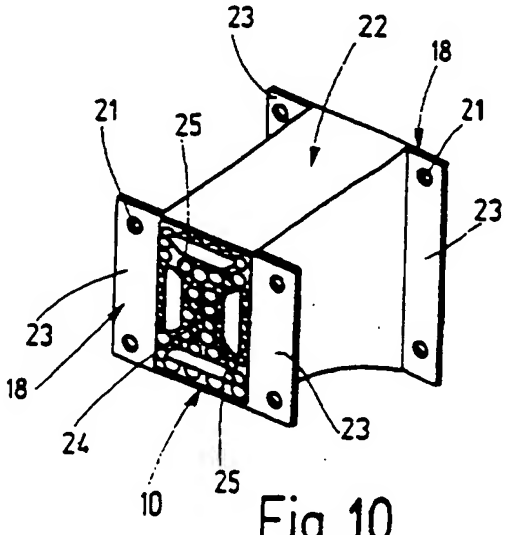

Fig. 10

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

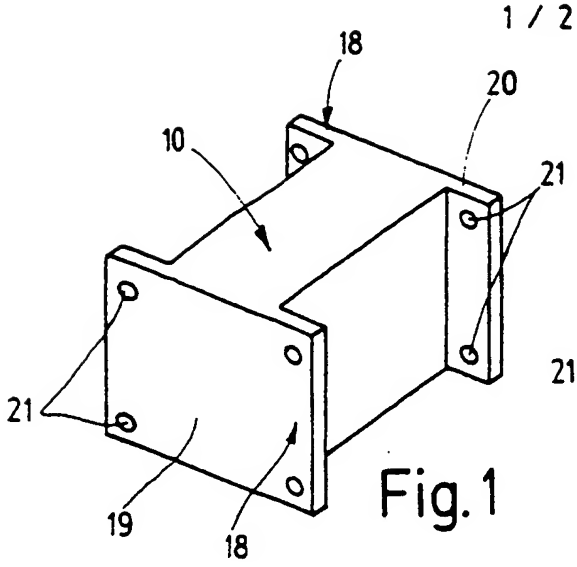

Fig. 1

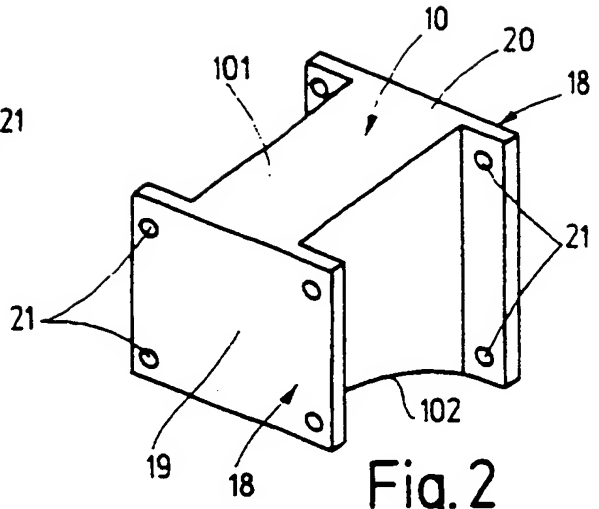

Fig. 2

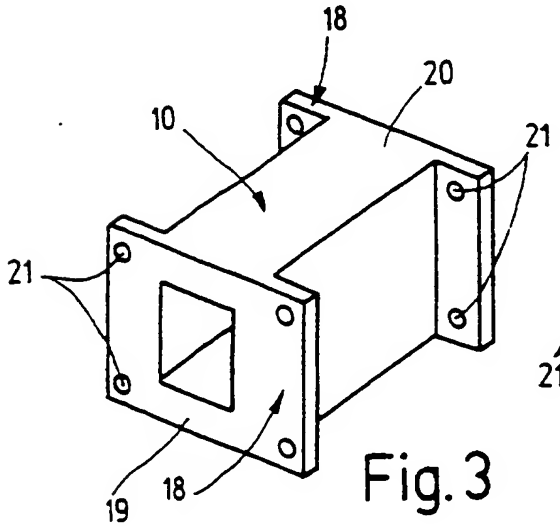

Fig. 3

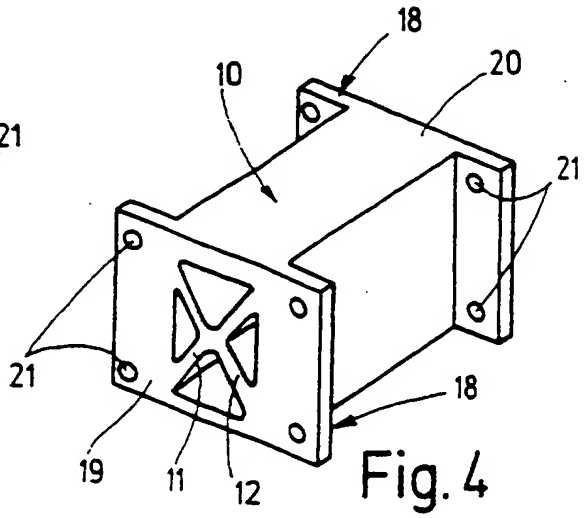

Fig. 4

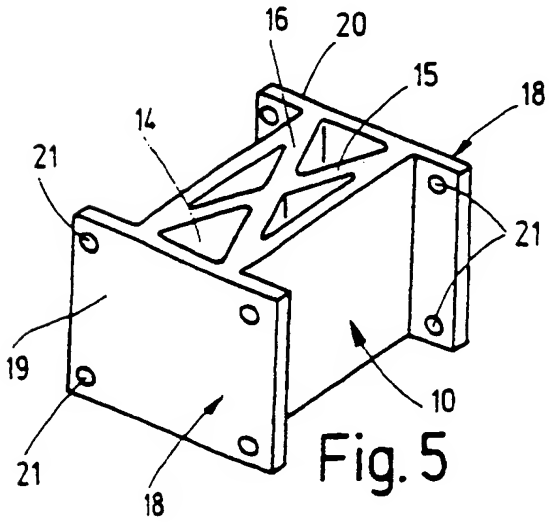

Fig. 5

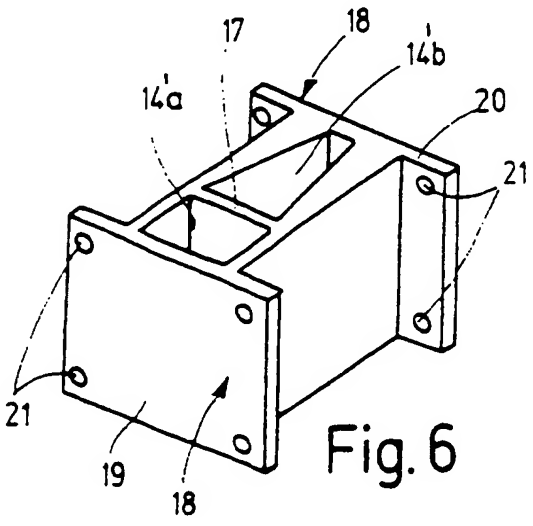

Fig. 6

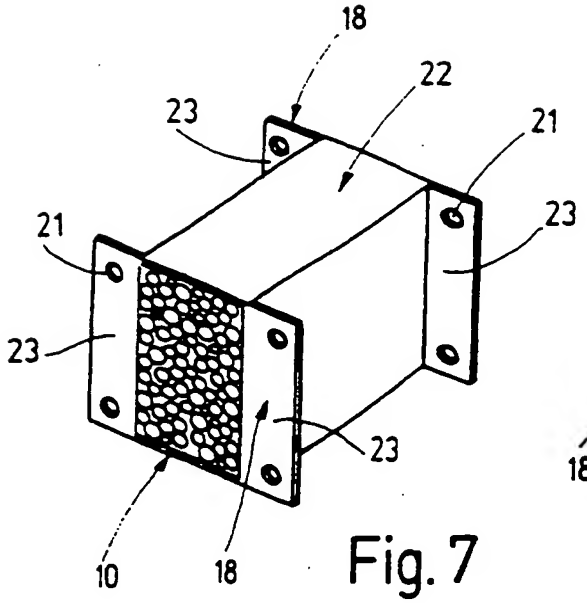

Fig. 7

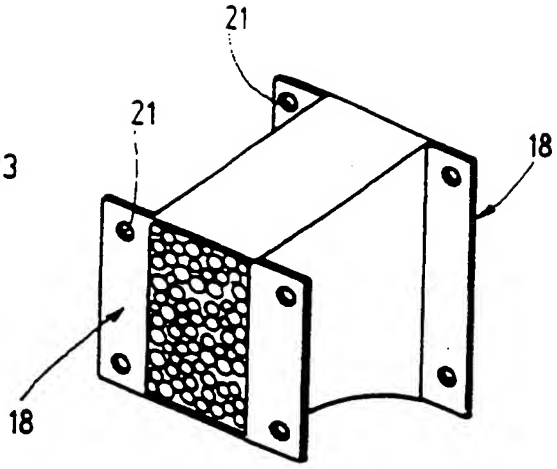

Fig. 8

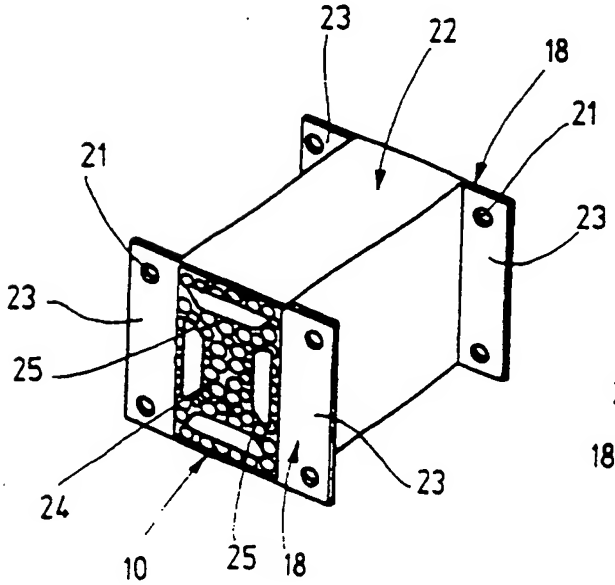

Fig. 9

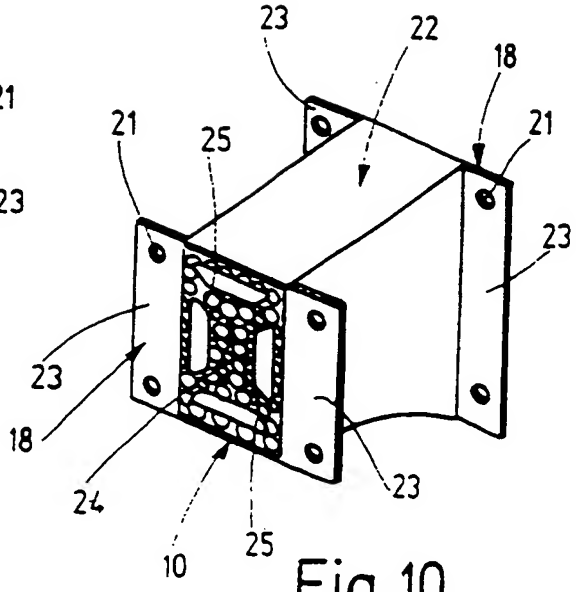

Fig. 10

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Energy-absorbing element

The invention relates to an energy-absorbing element, which is produced using metal foam, particularly but not exclusively, aluminium foam, for use in vehicles, in particular in motor vehicles.

In a known energy-absorbing element (DE 195 02 307 A1), which with a simple design has a high energy-absorbing capacity and can be fitted and exchanged quickly, a housing which is formed as an aluminium extruded section or a shaped sheet aluminium part has a filling of aluminium foam. The aluminium foam filling serves as an energy absorber, the absorption performance of which can additionally be adjusted by dividing the housing into chambers. The deformation of the deformation element can be controlled by adapting the configuration of the housing to the desired deformation, for example by varying the wall thickness of the housing or by designing it as bellows.

A known energy-absorbing element for reducing the impact energy in the event of a vehicle collision (JP 0 727 713 A) is composed of a plurality of core blocks which are arranged behind one another in the impact direction, are formed from a lightweight metal foam body and absorb the impact energy by collapsing up to a desired deformation pressure level. The length and width of the core blocks are dimensioned in such a way that they do not buckle or bulge sideways when compressed.

In a known shock-absorbing body for motor vehicles, which is arranged between bumper and bearer system (AT 394 004 B), in order to achieve a constant deformation resistance over the deformation path a cylindrical base body, lying in the impact direction, is provided in a region with radially encircling ribs, this region being delimited at one end by the bumper mounting and at the other end by an annular flange which protrudes radially from the base body. In the event of the design load of the shock-absorbing body being exceeded, the flange, which is provided with a groove, breaks in the transition region to the base body, and the next rib is pressed against the flange and also shears off. The process is repeated for each further rib situated beyond this. The annular flange which projects from the base body simultaneously serves to fix the shock-absorbing body on the bearer system, while a further attachment flange

is integrally moulded on the base body for attachment to the bumper mounting.

A known impact shock absorber made from aluminium alloy, which is arranged between a cross-member, designed as a hollow section, of a bumper and a longitudinal beam of the floor assembly of the motor vehicle (DE 195 33 366 A1), has a chamber which determines the properties of the impact shock absorber on impact and has two diagonal reinforcing ribs, a U-shaped chamber, which is used to attach the impact shock absorber to the cross-member, and a flange, which is arranged on that end side which is remote from the U-shaped chamber and serves for attachment to the longitudinal beam.

The present invention seeks to provide an energy-absorbing element of the type mentioned at the outset which has improved absorption properties and in which the desired absorption performance can be influenced in a controlled manner using simple measures.

According to the present invention there is provided an energy-absorbing element produced using metal foam, for use in vehicles, with fastening elements for attaching it to the vehicle structure, wherein the element is produced as a shaped body, which is adapted to the energy-absorption performance desired in a specific application, by the foaming process with a closed outer skin.

The energy-absorbing element according to the invention has the advantage that a powder-metallurgy production of the direct structure of the shaped body makes it possible to influence the energy-absorption performance of the element in a very controlled and very accurate manner. This structure can be adapted very precisely to the specific application, e.g. by means of a particular solid or hollow profile design or a framework structure with longitudinally, transversely or diagonally running ribs. The surface of the shaped body is already delivered in a closed-cell state after the foaming process. In contrast to the known energy-absorbing element with moulded foam filling, the absorption performance of the element according to the invention is set not only by the density of the metal foam but also by the structure of the metal foam shaped body. The production outlay is relatively low, since the shaped body is already in the finished state after the production process. The energy-absorbing element is easy to fit and can therefore be replaced quickly and cost-effectively in the event of a defect.

Expedient embodiments of the energy-absorbing element according to the invention, together with advantageous refinements and improvements of the invention, are given in the further patent claims.

According to an advantageous embodiment of the invention, the fastening elements for attachment to the vehicle structure are foamed integrally on the shaped body, an operation which is carried out simultaneously in the production process of the shaped body. The surface of the complete shaped body provided with the fastening elements is in this case already obtained in the closed-cell state.

According to a preferred embodiment of the invention, the foamed shaped body is also provided with an additional shell. This shell may be designed as a sheet metal covering or as a profile. The energy absorption potential of the element can additionally be influenced by selecting the thickness of the shell.

If, according to a preferred embodiment of the invention, the shell is produced from the same metal, in particular aluminium, the element can be recycled in a cost-saving manner without separating shaped body and shell.

The invention is described in more detail below with reference to preferred embodiments illustrated in the drawing, in which:

Figs 1 to 10 each show a perspective illustration of an energy-absorbing element in accordance with various embodiments.

The energy-absorbing element, various embodiments of which are illustrated in a perspective view in Figs 1 - 10, is a shaped body 10 which is produced from aluminium foam using a foaming process and the shape of which is adapted to the energy absorption performance of the element which is desired for a specific application. The outer skin of the shaped body 10 is already supplied in the closed-cell state by suitably controlling the foaming process. A suitable design which is adapted to the required application makes it possible to influence the energy absorption performance of the aluminium foam shaped body.

In Figs 1 and 2, the shaped body 10 is designed as a solid body, which in the embodiment shown in Fig. 1 has a cross-section which is constant along its longitudinal axis and in the embodiment shown in Fig. 2 has a cross-section which increases in the direction of its longitudinal axis. In the embodiment shown in Fig. 2, the vertical dimension, when in the installed position, of the shaped body 10 grows

with increasing length, which in the embodiment shown in Fig. 2 is achieved by the fact that the top side 101 of the shaped body 10 is planar and the opposite underside 102 of the shaped body 10 is designed with a concave curvature. In both embodiments, the shaped body 10 is designed as a cuboid. It is also possible for it to be designed as a cylinder.

In the embodiment shown in Fig. 3, the shaped body 10 is designed as a hollow body, in this case as a hollow square prism or as a hollow cuboid. In the embodiment shown in Fig. 4, the hollow body is reinforced on the inside by longitudinally running diagonal ribs or struts 11, 12, which intersect one another in the centre axis.

In the embodiment shown in Figs 5 and 6, the shaped body 10 is likewise designed as a hollow body reinforced with struts. However, unlike in the embodiments shown in Figs 3 and 4, the axis of the cavity 14 or 14' does not run in the direction of the longitudinal axis of the shaped body 10, but rather transversely thereto. The cavity 14 of the shaped body 10 in Fig. 5 is again reinforced with continuous longitudinal, diagonal struts 15 and 16, which intersect one another along the axis of the cavity 14. In the embodiment shown in Fig. 6, the cavity 14' is reinforced by a transverse strut 17, resulting in two continuous longitudinal cavity sections 14'a and 14'b, which lie one behind the other in the axial direction. In addition, the clear cross-section of the rear cavity section 14'b is of trapezoidal design, with the residual side wall width of the shaped body 10 increasing continuously in the direction running away from the cavity section 14'a.

All the energy-absorbing elements illustrated in Figs 1 - 6 have fastening elements 18 for attachment to the vehicle structure, which fastening elements are integrally formed on the shaped body 10 and are foamed on simultaneously during the production of the shaped body 10 using a foaming process, so that the shaped body 10 is already finished, with a closed outer skin, after the foaming process. In all the embodiments in accordance with Figs 1 - 6, the fastening elements 18 are designed as end flanges 19, 20, which on opposite sides of the shaped body 10 project beyond the latter and have two through-holes 21 for the passage of attachment screws in each projecting region. In one application, given by way of example, the two end flanges 19, 20 are used to attach shaped body 10 to the bumper, on one side, and to a

longitudinal beam of the body bottom section, on the other side.

In the embodiments of the energy-absorbing element illustrated in Figs 7 - 10, the shaped body 10 produced by foaming from aluminium foam in various shaped structures which are adapted to the required application is additionally provided with a shell 22. In the embodiment of Fig. 6, this shell 22 is produced from sheet metal, preferably from sheet aluminium. However, it may equally be produced as a profile. The fastening elements 18, which are also present on the energy-absorbing elements for attaching them to the vehicle structure, are not formed integrally on the shaped body 10, but rather are bent off from the shell 22, of which they form an integral part. These fastening elements 18, as attachment brackets 23, project outwards at right angles at each end of the shell 22 from the mutually remote side faces of the shell 22 and each have two through-holes 21 for the passage of attachment screws. By means of the attachment brackets 23, of which there are a total of four, the energy-absorbing element is screwed into the chassis structure at its ends.

In the embodiment shown in Fig. 7 and Fig. 8, the shaped body 10, in the same way as in the embodiment in Figs 1 and 2, is designed as a solid body made of aluminium foam. The two embodiments shown in Fig. 7 and Fig. 8 differ from the embodiments shown in Figs 1 and 2 only by the fact that the additional shell 22 is provided and the fastening elements 18 are formed by attachment brackets 23 bent out of the shell 22.

In the two embodiments shown in Figs 9 and 10, while the form of the shell 22 does not change, the shaped body 10 is designed not as a solid body but rather as a hollow body with an internal framework structure comprising longitudinal and diagonal struts. A longitudinal strut 24, which is coaxial with the axis of the shaped body, is in this case connected to the hollow body via a total of four smaller, continuous longitudinal, diagonal struts 25.

The invention is not limited to the embodiments described. For example, other metal foams, in particular lightweight metal foam, or foams of alloys of these metals can also be used as well as aluminium foam for producing the shaped body.

Claims

1. An energy-absorbing element produced using metal foam, for use in vehicles, with fastening elements for attaching it to the vehicle structure, wherein the element is produced as a shaped body, which is adapted to the energy-absorption performance desired in a specific application, by the foaming process with a closed outer skin.

2. An element according to Claim 1, wherein the shaped body is finished in the foaming process with a closed outer skin.

3. An element according to Claim 1, wherein the shaped body is finished after the foaming process.

4. An element according to any one of Claims 1 - 3, wherein the fastening elements are foamed integrally on the shaped body.

5. An element according to any one of Claims 1 - 3, wherein the shaped body is provided with an additional shell.

6. An element according to Claim 5, wherein the fastening elements on the shell are formed integrally with the latter.

7. An element according to Claim 5 or 6, wherein the shell comprises a sheet casing or section.

8. An element according to any one of Claims 5 to 7, wherein the shell is made from the same metal as the shaped body.

9. An element according to Claim 8, wherein the shell is made from aluminium.

10. An element according to any one of Claims 1 - 9, wherein the shaped body has a framework structure with longitudinal and/or transverse and/or diagonal ribs or struts.

11. An energy-absorbing element produced using metal foam, for use in vehicles, substantially as described herein with reference to and as illustrated in the accompanying drawings.

The Patent Office

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Application No: GB 9811164.4 **Examiner:** Colin Thompson
Claims searched: 1 to 11 **Date of search:** 28 July 1998

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.P): F2S (SCM), B7B (BSEB,BSES)

Int Cl (Ed.6): F16F 7/12, B60R 19/34, B62D 21/15

Other: Online: WPI, EDOC, JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB 2295993 A	(Fuji Jukogyo KK) See especially Fig 1C	1,5,7-9
X	GB 1183920 A	(Ford Motor Co Ltd) See Figs 6 & 7	1,5
X	US 5194199 A	(Thum) Whole document relevant	1
X	US 3842944 A	(Shiotani) See Fig 4	1,5

X Document indicating lack of novelty or inventive step
Y Document indicating lack of inventive step if combined with one or more other documents of same category.
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